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[Date of Submission]	February 4, 2005
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[Arguments]

(1) In the Notification of Reason for Refusal for this patent application dated on December 3, 2004, we received the following reasons for the rejection,

(Reason 1) the invention according to claims 1 to 13 is unpatentable under the provision of Article 29, paragraph 2 of the patent law,

(reason 2) the present application does not satisfy the requirements defined by the provision of Article 36, Paragraph 4, and Paragraph 6 (i) and (ii) of the Patent Law.

By filing the amendments submitted on the same date of this argument, we amend claims and detailed description of the invention. With the amendments, we believe that the reasons for refusal are eliminated. Hereinafter, the reason for it will be described.

Note that the cited references 1 to 12 are as follows.

Reference 1: Japanese Patent Application Laid-Open No. 2000-002847
(e.g., Fig. 1, as to the condition)

Reference 2: Japanese Patent Application Laid-Open No. H11-337853
(e.g., Fig. 1, as to the condition)

Reference 3: Japanese Patent Application Laid-Open No. H11-084118
(e.g., paragraph [0007])

Reference 4: Japanese Patent Application Laid-Open No. H11-271655
(e.g., Figs. 5-7, paragraph [0040])

Reference 5: Japanese Patent Application Laid-Open No. H06-230309
(e.g., Fig. 3, paragraphs [0026] and [0048])

Reference 6: Japanese Patent Application Laid-Open No. H11-307443
(e.g., paragraphs [0007] and [0008])

Reference 7: Japanese Patent Application Laid-Open No. H04-212119

(e.g., Figs. 1, 11, and 12)
Reference 8: Japanese Patent Application Laid-Open No. S51-120737
(e.g., Figs. 2-4)
Reference 9: Japanese Patent Application Laid-Open No. H10-325934
(e.g., Figs.)
Reference 10: Japanese Patent Application Laid-Open No. S62-182709
(e.g., Figs. 4 and 5, and line 11 of right-top column to line 13 of left-bottom column in page 4)
Reference 11: Japanese Patent Application Laid-Open No. H07-287180
(e.g., paragraphs [0003] and [0015], Fig. 1)
Reference 12: Japanese Patent Application Laid-Open No. S63-273823
(e.g., Fig. 6, and lines 11 to 17 of left-top column in page 8)

(2) The outline of the amendments to claims is as follows.
- Claim 1 is amended to include the features of claims 7, 9, and 10, and amended based on the description of the paragraphs [0045] and [0048] to [0050] of the specification originally attached to the request.
- Claim 2 is amended in accordance with the present amendment to claim 1.
- Claims 3 and 4 are amended to renumber claims 12 and 13, respectively, and amended the dependency thereof in accordance with the renumbering of claims.

(3) The feature of the invention according to claim 1 of this application
(3-1) The feature of the invention according to claim 1 of this application includes:
(A1) a scanning optical apparatus including incidence optical means for causing at least one beam emitted from light source means made incident on deflecting means; and imaging means, to which the light beam reflected and deflected by the deflecting means is incident, having diffracting optical element provided with a diffracting surface on the emitting surface thereof, in which the first-order diffracted light used generated during passing through the diffracting surface disposed on the diffracting optical element is imaged on the surface to be scanned by the imaging means,
(A2) restricting means for restricting the light beams diameter of the sixth-order unnecessary diffracted light in the sub-scanning direction is disposed on the optical path between the diffracting surface and the surface to be scanned where the sixth-order unnecessary diffracted light is generated at the diffracting surface, and is reflected on the incidence surface of the diffractive optical element and the scanning is performed with the unnecessary diffracted light on the surface to be scanned in the main scanning direction, and
(A3) the following conditional expressions are satisfied,
$\sqrt{}(S/\varphi m) < Lm/Lo$ ......(3),

$Lm/Lo < 0.8$ ......(1),

where Lo represents the effective scanning width of the first-order diffracted light used, Lm represents the scanning width of the sixth-order unnecessary diffracted light, S represents the width of opening of the restricting means in the sub-scanning direction, and φm represents size of the sixth-order unnecessary diffracted light in the sub-scanning direction at the position where the restricting means is disposed.

(3-2) The invention according to claim 1, by adopting the configuration (A1) to (A3), and specifically by specifying each of components to satisfy the conditional expression (3) in a scanning optical apparatus satisfying the conditional expression (1), an effect (a1) can be obtained.

(a1) when correcting magnification deviation and focus deviation in the main scanning direction due to change in temperature by providing a diffracting portion (surface) in imaging means, the sixth-order unnecessary diffracted light, which is a reflected sixth-order diffracted light generated at the diffracting surface; is imaged on the surface to be scanned; and is maleficent light, can be reduced.

(3-3) Further feature of the invention according to claim 1

(3-3-1) The problem 1 of the invention according to claim 1 is to prevent the quality of the image from deteriorating due to the stray light (the sixth-order unnecessary diffracted light) which arises as a significant problem in a scanning optical apparatus satisfying the following conditional expression,

$Lm/Lo < 0.8$ ......(1).

(see paragraphs [0014] to [0015] in the specification)

The reason for adopting the scanning optical apparatus satisfying the conditional expression (1) is to effectively utilize the fθ characteristic of the imaging optical system.

As shown in Fig. 11 attached to this application, in a case of a scanning optical apparatus satisfying, $Lm/Lo = 0.73 < 0.8$ (described in paragraph [0047]), the quality of the image deteriorates worse in the vicinity of the end portion (around ±80mm) of the scanning width Lm of the sixth-order unnecessary diffracted light due to the stray light (the sixth-order unnecessary diffracted light). The reason is that the region where the stray light (the sixth-order unnecessary diffracted light) concentrates exists within the real image forming range.

On the other hand, as shown in Fig. 11 attached to this application, the deterioration of the quality of the image even in the vicinity of the end portion of the effective scanning width Lo due to the stray light (the sixth-order unnecessary diffracted light) becomes a problem in the case of $Lm/Lo=1$. However, the effective scanning width Lo is made a little wider than the real image forming range. Therefore, the vicinity of the end portion of the effective scanning width Lo is out of the image forming range, so that the stray light (the sixth-order unnecessary diffracted light) doesn't cause the deterioration of the quality of the image in the vicinity

of the end portion of the effective scanning width Lo.

That is, the problem 1 of the invention according to claim 1 is a problem which arises only in a particular scanning optical apparatus which satisfies the conditional expression (1), $Lm/Lo<0.8$.

(3-3-2) In order to solve the problem 1 of the invention according to claim 1, the restricting means described in the configuration (A2) is needed. However, the inventor of this invention first found that the stray light (sixth-order unnecessary diffracted light) in the vicinity of the end portion of the effective scanning width Lo can be effectively eliminated by setting the width S in the sub-scanning direction of the opening portion of the restricting means so as to satisfy the conditional expression (3) in consideration of the effective scanning width of the first-order diffracted light used Lo, the scanning width of the sixth-order unnecessary diffracted light Lm, and the size φm of the sixth-order unnecessary diffracted light in the sub-scanning direction at the position where the restricting means is disposed.

Further, the inventor of the present invention first found that although the smaller S/φm is, the better the stray light (sixth-order unnecessary diffracted light) can be shielded, the problem 2 that first-order diffracted light used is also shielded arises. Therefore, the upper limit value to obtain predetermined quality of the image in a scanning optical system (to suppress the deterioration of the quality of the image due to the stray light) is set so as to satisfy the conditional expression (3). Particularly, the inventor of the present invention first found that the upper limit value is controlled by the value Lm/Lo, and formulated the relation as the conditional expression (1).

(3-3-3) Next, the conditional expression (3) of the configuration (A3),

$\sqrt{\ }(S/\varphi m) < Lm/Lo$ ......(3),

is explained below with reference to paragraph [0052] of the specification.

Although the stray light (the sixth-order unnecessary diffracted light) doesn't cause the deterioration of the quality of the image in the case of $Lm/Lo=1$, it significantly does in the case of $Lm/Lo<0.8$.

For example, if $Lm/Lo=0.73$ and the scanning speed of the stray light is constant, the energy density on the surface to be scanned effected by the stray light is substantially constant independent of the image height and is $Lo/Lm=1/0.73=1.37$ times greater than that in the case of $Lm/Lo=1$ with no deterioration of image quality. Therefore, providing the slit opening portion 7a in the slit member 7 (restricting means) to shield a portion of the stray light in the sub-scanning direction so as to set the energy density 0.73 times (that is Lm/Lo times) larger, the energy density becomes same as that in the case of $Lm/Lo=1$ with no deterioration of image quality. At this time, the width of the slit opening portion 7a is set to equal to or smaller than Lm/Lo times the light beam width of the stray light in the

sub-scanning direction.

That is, it is set to satisfy the following conditional expression (a),

$S < \varphi m \times Lm/Lo$ ......(a).

However, the scanning speed of the stray light is actually not constant as shown in Fig. 11, so that the scanning speed gradually decrease as moving toward off-axis even if the scanning speed in the vicinity on the axis is substantially constant. As a result, the energy density of the stray light in the vicinity of the image height Lm=±80mm is greater than that in the vicinity on the axis. The average of the energy density in the range of the scanning range of the stray light -80mm to +80mm is Lo/Lm=1/0.73=1.37 times, which is as same as above case. However, the energy density increases in the vicinity of Lm=±80mm. Therefore, the stray light needs to be shielded more than defined in the conditional expression (a).

In the configuration of this invention, since the stray light cannot be shielded in the main scanning direction, the slit opening portion 7a needs to be configured small in the sub-scanning direction, so that it is configured to satisfy the following conditional expression (b),

$S < \varphi m \times (Lm/Lo)^2$ ......(b).

Transforming the conditional expression (b), the conditional expression (3),

$\sqrt{(S/\varphi m)} < Lm/Lo$ ......(3),

is obtained.

(4) Argument to the reason (1) in the Notification of Reason for Refusal

(4-1) The cited references 1 and 2 disclose regarding a scanning optical apparatus using a diffracting optical element, each of which uses a first-order diffracted light to scan a surface to be scanned. Further, although it is conceivable that unnecessary diffracted light is also generated at the diffracting optical element, it is not clear that the scanning optical apparatuses in the cited references 1 and 2 satisfy Lm/Lo<0.8 or not.

Since each of the cited references 1 and 2 doesn't disclose the position and size of the stop, it is impossible to calculate Lm and φm.

Further, each of the cited references 1 and 2 doesn't disclose a member corresponding to the restricting means according to claim 1. Therefore, the width S is also not disclosed.

As described above, the cited references 1 and 2 do not disclose and suggest the configurations (A2) and (A3) of the invention according to claim 1.

(4-2) The cited references 3 to 7 disclose that the unnecessary diffracted light becomes the stray light in a optical system including a diffracting optical element. However, in a scanning optical system, the cited references 3 to 7 do not disclose the scanning optical system satisfying the conditional expression (1) Lm/Lo<0.8, the scanning width Lm of the sixth-order unnecessary diffracted light, the width

S of the restricting means in the sub-scanning direction, and the size of the sub-scanning apparatus of the sixth-order unnecessary diffracted light φm, at all.

The cited references 3 to 7 do not disclose and suggest the configurations (A2) and (A3) of the invention according to claim 1.

(4-3) The cited references 8 to 12 disclose a shielding member relating to the restricting means according to claim 1 of this invention. However, it is not disclosed to apply the shielding member to eliminate the unnecessary light generated at the diffracting optical element of the scanning optical apparatus.

Specifically, it is not disclosed regarding application of the shielding member to a scanning optical apparatus satisfying the conditional expression (1), the scanning width Lm of the sixth-order unnecessary diffracted light, the width S of the restricting means in the sub-scanning direction, and the size of the sub-scanning apparatus on the sixth-order unnecessary diffracted light φm, at all.

The cited references 8 to 12 do not disclose and suggest the configurations (A2) and (A3) of the invention according to claim 1.

(4-4) As described above, each of the cited references 1 to 12 does not disclose and suggest to, in a scanning optical apparatus satisfying the conditional expression (1), set the scanning width Lm of the sixth-order unnecessary diffracted light, the width S of the restricting means in the sub-scanning direction, and the size φm of the sub-scanning apparatus of the sixth-order unnecessary diffracted light so as to satisfy the conditional expression (2), in order to reduce the sixth-order unnecessary diffracted light, which is reflected sixth-order diffracted light generated at the diffracting surface; is imaged on the surface to be scanned; and is maleficent light, when correcting the magnification deviation and focus deviation in the main scanning direction due to change in temperature by providing a diffracting portion (diffracting surface) in the imaging means.

Therefore, it is impossible even for the skilled in the art to derive the configurations (A2) and (A3) of the invention according to claim 1 from the cited references 1 to 12.

Accordingly, it cannot be conceivable that the invention according to claim 1 can be invented by the skilled in the art from the cited references 1 to 12 and is not patentable.

(4-5) The inventions according to the other claims than claim 1 include claim 1. Therefore, it cannot be also conceivable the inventions according to the other claims than claim 1 is not patentable because of the same reasons of (4-1) to (4-4).

(5) Argument to the reason (2) in the Notification of Reason for Refusal

(5-1) Argument to the reasons 1, 4, and 5

In the amendment submitted on the same date of this argument, by the amendment to claim 1 (to include the configurations of claims 7, 9, and 10), the configuration of claim 1 is clarified so that the skilled in the art can

perform the invention. Therefore, we believe that the reasons 1, 4, and 5 are eliminated.

(5-2) Argument to the reason 3

Claim 3 is canceled.

By this cancel, we believe that the reason 3 is eliminated.

(5-3) Argument to the reasons 2 and 6

How "the scanning width Lm of the stray light of the unnecessary diffracted light" and "the size φm of the unnecessary diffracted light in the sub-scanning direction at the position where the restricting means is disposed" are introduced will be explained below. In order to specifically explain it, the explanation will be provided with numerical embodiments.

The shape of the toric lens 61 constituting the imaging means 6 shown in Fig. 1 attached to this application and the shape of the diffracting optical element 62 are respectively expressed as follows.

(A) Toric lens

Assuming that, with the intersection between the optical axis of the toric lens and an aspherical shape within the main scanning direction expressed by a function including up to tenth-order terms being the original, the optical axis be x-axis, an axis orthogonal to the optical axis in the main scanning direction be y-axis, and an axis orthogonal to the optical axis in the sub-scanning direction be z-axis, the direction of the meridional line corresponding to the main scanning direction can be expressed by the following equation,

$$x = Y^2/R/(1+(1-(1+K)(Y/R)^2)^{1/2}) \ +B_4Y^4+B_6Y^6+B_8Y^8+B_{10}Y^{10},$$

where R represents the radius of the curvature, K, B_4, B_6, B_8, and B_{10} are aspherical coefficients. And the direction of the sagittal line corresponding to the sub-scanning direction (direction including the optical axis and orthogonal to the main scanning direction) can be expressed by the following equation,

$$S = Z^2/r'/(1+(1-(Z/r')^2)^{1/2}),$$

where,

$$r' = r_0(1+D_2Y^2+D_4Y^4+D_6Y^6+D_8Y^8+D_{10}Y^{10}),$$

and where r_0 represents the radius of the curvature of the sagittal line on the optical axis, D_2, D_4, D_6, D_8, and D_{10} are aspherical coefficients.

(B) Diffracting optical element

The shape of the diffracting optical element is expressed by a diffraction surface, which is expressed by a phase function including up to tenth-order terms in the main scanning direction and a phase function including up to second-order terms in the sub-scanning direction,

$$\varphi = m\lambda = b2Y2+b4Y4+b6Y6+b8Y8+b10Y10$$
$$+(d0+d1Y+d2Y2+d3Y3+d4Y4)Z2,$$

where φ represents a phase function, m represents a diffraction order, λ represents a wavelength used (that is 780nm), Y represents a height from the optical axis b2, b4, b6, d0, d1, d2, d3, and d4 represent phase coefficient. In this embodiment, m=+1-order diffracted light is used as a normal scanning light. And in the sixth-order reflected and

diffracted light, used as a reflected light beam (m=+6).

The numerical example (design values) of the imaging means 6 is shown in Table 1 for the explanation.

In the Table 1, the surface 1 corresponds to the incidence surface of the toric lens 61, the surface 2 corresponds to the emitting surface, the surface 3 corresponds to the incidence surface 63 of the diffracting optical element 62, and the surface 4 corresponds to the emitting surface 64. The surface 0 in Table 1 corresponds to the deflecting point of the polygon mirror 5.

Table 1

Surface Number	Surface Interval	Refractive Index	
0	28.5	1.000	Reflecting Surface
1	8.0	1.524	Transmitting Surface
2	57.5	1.000	Transmitting Surface
3	4.0	1.524	Transmitting Surface
4	125.0	1.000	Transmitting Surface

Main scanning shape

	R	K	B4	B6	B8	B10
Surface 1	-6.222E+01	-2.511E+00	3.374E-06	1.680E-10	0.000E+00	0.000E+00
Surface 2	-3.772E+01	-8.873E-01	2.165E-06	1.719E-09	0.000E+00	0.000E+00
Surface 3	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
Surface 4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Sub-scanning shape

	R	D2	D4	D6	D8	D10
Surface 1	1.179E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Surface 2	1.376E+01	-1.307E-04	8.246E-08	0.000E+00	0.000E+00	0.000E+00
Surface 3	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Surface 4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Diffraction Grating Order m=+1

	b2	b4	b6	b8	b10
Surface 4	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-12
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E-00	2.123E-13

Here, the F-number of the Fθ lens is F=184.10mm/rad. Therefore, the scanning view angle θmax for the scanning the range Lo/2=±110 is ±34.2°.

And the disposition of the incidence optical system disposed on the optical path between the light source 1 and polygonal mirror 5 is as follows.

	Surface	R(Meridian Line)	r(Sagittal Line)	d	N
Light Source	-6	∞	∞	29.6	1
Collimator	-5	178.472	178.472	2.00	1.762
Lens	-4	-26.645	-26.645	3.00	1

Stop	-3	∞	∞	6.52	
Cylinder	-2	∞	41.29	3.00	1.511
	-1	∞	∞	75.98	

The aperture stop is an ellipse in shape, the diameter thereof in the direction parallel to the paper surface (main scanning direction) is 4.9 and the diameter thereof in the direction perpendicular to the paper surface (sub-scanning direction) is 3.72.

The light beam trace in this numerical embodiment (Table 1) can be performed by using an optical light beam trace software offered commercially (such as codeV offered by Optical Research Associates) or a optical trace software developed in Canon Kabushiki Kaisha. The light beam 12 shown in Fig. 10 of the present application is the illustrated optical trace, which is optical-traced by the software developed in Canon Kabushiki Kaisha.

Here, the unnecessary diffracted light is defined as follows. The sixth-order reflected and diffracted light generated at the emitting surface 64 (the surface 4) of the diffracting optical element 62 is surface-reflected on the incidence surface 63 (the surface 3) of the diffracting optical element 62, then the light is transmitted through and diffracted by the emitting surface 64 (the surface 4) of the diffracting optical element 62 and traveling toward the surface to be scanned as a transmitted and diffracted light. The unnecessary diffracted light is defined as the transmitted and diffracted light. On the contrary, the trace of the stray light of the unnecessary diffracted light is performed by setting the positional information as described below. That is, the trace is performed by adding two surfaces, the surface 4′ for the surface information with respect to the sixth-order reflected light on the surface 4 and the surface 3′ for the surface information with respect to the sixth-order surface-reflected light on the surface 3. Specifically, it becomes as shown in Table 2.

Table 2

Surface Number	Surface Interval	Refractive Index	
0	28.5	1.000	Reflecting Surface
1	8.0	1.524	Transmitting Surface
2	57.5	1.000	Transmitting Surface
3	4.0	1.524	Transmitting Surface
4′	-4.0	-1.524	Reflecting Surface
3′	4.0	1.524	Reflecting Surface
4	125.0	1.000	Transmitting Surface

	R	K	B4	B6	B8	B10
1	-6.222E+01	-2.511E+00	3.374E-06	1.680E-10	0.000E+00	0.000E+00
2	-3.772E+01	-8.873E-01	2.165E-06	1.719E-09	0.000E+00	0.000E+00

3	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
4'	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3'	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

	R	D2	D4	D6	D8	D10
1	1.179E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.376E+01	-1.307E-04	8.246E-08	0.000E+00	0.000E+00	0.000E+00
3	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4'	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3'	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

Diffraction Grating Order m=+6

Surface	b2	b4	b6	b8	b10
4'	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-12
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E-00	2.123E-13

Diffraction Grating Order m=+1

Surface	b2	b4	b6	b8	b10
4	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-12
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E-00	2.123E-13

The light beam trace in this numerical embodiment (Table 2) can be also performed by using an optical light beam trace software. The stray light 13 shown in Fig. 1 (main scanning cross sectional view) of the present application is the illustrated optical trace, which is optical-traced by the software developed in Canon Kabushiki Kaisha.

The range Lm of "the scanning width of the stray light of the unnecessary diffracted light" in Fig. 1 is a range in which the stray light 13 scans with respect to the range of scanning view angle $\theta max=\pm 34.2$ with which the range of $Lo/2=\pm 110$ is scanned. That is, in the numerical embodiment shown in Table 2, the range Lm can be calculated by tracing over the scanning view angle θ within the range of the view angle $\theta max=\pm 34.2$ by the optical trace software to detect where the light beam reaches on the surface to be scanned. The scanning range is about ±80 (Lm=160) as described in paragraph [0047] of the specification and as shown in Fig. 11.

Fig. 11 shows what point on the surface to be scanned the principal ray in the main scanning direction and two marginal rays reach. The two marginal rays are defined by the above-described aperture stop 3 (width 4.9 in the main scanning direction).

On the other hand, "the size of the unnecessary diffracted light in the sub-scanning direction at the position where the restricting means is disposed" can be calculated in a same manner. Specifically, in Table 2, the trace is performed with the distance between the emitting surface 64 of the diffracting optical element 62 (the surface 4) and the

surface to be scanned being 125. The restricting means 7 is disposed between the diffracting surface 64 and the surface to be scanned 9 as described in paragraph [0039] of the specification, and the like. Therefore, the distance X between the diffracting surface 64 and the restricting means 7 is not longer than 125. In order to trace the behavior of the stray light on the restricting means, by changing the surface interval of the surface 4 125 as shown in Table 2 to X, the trace can be performed by using the optical trace software. The stray light 13 shown in Fig. 2 (sub-scanning cross sectional view) of the present application is the illustrated optical trace, which is optical-traced by the software developed in Canon Kabushiki Kaisha. The stray light 13 shown in Fig. 2 is a marginal ray in the sub-scanning direction. The two marginal rays are defined by the above-described aperture stop 3 (width 3.72 in the sub-scanning direction).

With the above explanation, we believe that it is clearly explained that how "the scanning width Lm of the stray light of the unnecessary diffracted light" and "the size φm of the unnecessary diffracted light in the sub-scanning direction at the position where the restricting means is disposed" are introduced.

Note that we believe that above-described technical matter can be easily understood by the skilled in the art.

By this argument, we believe the reasons 2 and 6 are eliminated.

(5-4) By the above argument, we believe the reason (2) is eliminated.

(6) By the above argument, we believe the reasons (1) and (2) for the refusal for the present application do not exist. Consequently, we would like you to examine the present application again, and to decide to grant a patent to this application, quickly.

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【意見の内容】
（１）本出願に対する平成１６年１２月３日付の拒絶理由通知書において、
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（理由２）本出願は特許法第３６条第４項第６項第１号、第２号に規定する要件を満たしていない、
との通知を受けた。
　そこで同日付の手続補正書により明細書の特許請求の範囲及び発明の詳細な説明の欄を補正することにより、上記拒絶理由を解消したと思料するので、以下その理由を述べる。
　尚、刊行物１〜１２は次のとおりである。
刊行物１：特開２０００−００２８４７号公報（図１等。前提について、）
刊行物２：特開平１１−３３７８５３号公報（図１等。前提について）
刊行物３：特開平１１−０８４１１８号公報（［０００７］欄等）
刊行物４：特開平１１−２７１６５５号公報（図５−７、［００４０］欄等）
刊行物５：特開平０６−２３０３０９号公報
（図３、［００２６］、［００４８］欄等）
刊行物６：特開平１１−３０７４４３号公報
（［０００７］、［０００８］欄等）
刊行物７：特開平０４−２１２１１９号公報（図１、図１１、図１２等）
刊行物８：特開昭５１−１２０７３７号公報（図２−４等）
刊行物９：特開平１０−３２５９３４号公報（図面等）
刊行物１０：特開昭６２−１８２７０９号公報
（図４、図５、４頁右上欄１１行−左下欄１３行等）
刊行物１１：特開平０７−２８７１８０号公報
（［０００３］、［００１５］、図１等）
刊行物１２：特開昭６３−２７３８２３号公報
（図６、８頁左上欄１１−１７行等）
（２）特許請求の範囲の補正の概略は次のとおりである。
・請求項１は、旧請求項１に旧請求項７、９、１０を付加するとともに出願当初の明細書の段落番号［００４５］、［００４８］〜［００５０］等の記載に基づいて補正したものである。
・請求項２は、旧請求項２を請求項１の補正に伴って補正したものである。
・請求項３、４は旧請求項１２、１３の項番を繰り上げるとともに従属項を適宜補正したものである。
（３）本出願の請求項１に係る発明の特徴
（３−１）本出願の請求項１の発明は、

（Ａ１）光源手段から出射された少なくとも１つの光束を偏向手段に入射させる入射光学手段と、該偏向手段で反射偏向に光束が入射する、出射面に回折面を設けた回折光学素子を含む結像手段とを有し、

該結像手段は、該回折光学素子の出射面に設けた回折面を透過する際に発生した１次使用回折光を該被走査面上に結像させている走査光学装置であること、

（Ａ２）該回折面で生じ、該回折光学素子の入射面で反射し、該被走査面上を主走査方向に走査する６次不要回折光の副走査方向の光束径を制限する制限手段が該回折面と該被走査面との間の光路中に設けられていること、

（Ａ３）該１次使用回折光の有効走査幅をＬｏ、該６次不要回折光の走査幅をＬｍ、該制限手段の開口部の副走査方向の幅をＳ、該制限手段の置かれた場所における該６次不要回折光の副走査方向の大きさをφｍとしたとき、

【数１】

$$\sqrt{S/\phi m} < Lm/Lo \cdots\cdots (3)$$

$$Lm/Lo < 0.8 \cdots\cdots (1)$$

なる条件を満足すること、

を特徴としている。

（３－２）請求項１の発明は、構成（Ａ１）～（Ａ３）をとることによって、特に条件式（１）を満足する走査光学装置において、条件式（３）を満足するように各要素を特定することによって、

（ａ１）結像手段に回折部（回折面）を用いて温度変化に伴う主走査方向の倍率変化及びピント変化を補正するときに、該回折面から生ずる反射６次回折光であって被走査面に結像し、有害光となる６次不要回折光を低減させることができる、

という効果を得ている。

（３－３）請求項１の発明の更なる特徴

（３－３－１）請求項１の発明の課題（１）は、

$$Lm/Lo < 0.8 \cdots\cdots (1)$$

を満たす走査光学装置で顕著に問題となる迷光（６次不要回折光）による画質の劣化を防止することである（「００１４」～「００１５」記載）。

条件式（１）を満たす走査光学装置にする理由は、結像光学系のｆθ特性を良好に使用するためである。

本出願に添付した図１１の如く、Ｌｍ/Ｌｏ＝０．７３＜０．８の走査光学装置の場合（「００４７」記載）、６次不要回折光の走査幅Ｌｍの端部近傍（±８０mm付近）で迷光（６次不要回折光）による画質の劣化が増大する。その理由は、迷光（６次不要回折光）が集中する領域が実際の画像形成領域であるためである。

一方、本出願に添付した図１１に示すようにＬｍ/Ｌｏ＝１の場合、有効走査幅Ｌｏの端部近傍でも迷光（６次不要回折光）による画質の劣化が問題となる。しかしながら有効走査幅Ｌｏは実際の画像形成領域より少し余裕を持たせている。この為有効走査幅Ｌｏの端部近傍は非画像形成領域となるので、有効走査幅Ｌｏの端部近傍で迷光（６次不要回折光）は画質の劣化に寄与しない。

つまり、請求項１の発明の課題（１）は、条件式（１）のＬｍ/Ｌｏ＜０．８を満たす特殊な走査光学装置でのみ発生する課題である。

（３－３－２）請求項１の発明の課題（１）を解決するためには構成（Ａ２）の制限手段が必要となるが、本発明者は、構成（Ａ３）の如く制限手段の開口部の副走査方向の幅Ｓを、１次使用回折光の有効走査幅Ｌｏ、６次不要回折光の走査幅Ｌｍ、制限手段の置かれた場所における６次不要回折光の副走査方向の大きさφｍの３つのパラメータを鑑みて条件式（３）の如く設定すれば有効走査幅Ｌｏの端部近傍で迷光（６次不要回折光）を有効に除去できることを初めて見出した。

更に本発明者は、Ｓ／φｍの値は小さければ小さい程、迷光（６次不要回折光）は遮蔽

できるが、反面、１次使用回折光も遮蔽してしまうという課題（２）が新たに発生するので、走査光学装置において所定の画質を得るための（迷光による画質劣化を抑制）上限値を条件式（３）の如く設定すれば良いことを初めて見出した。特に本発明者は、その上限値がＬｍ/Ｌｏの値に支配されることを初めて見出し条件式（１）の如く設定した。
（３－３－３）次に構成（Ａ３）の条件式（３）
【数２】

$$「\sqrt{S/\phi m} < Lm/Lo \cdot\cdot\cdot\cdot (3)」$$

を「００５２」を参照して以下に説明する。
Ｌｍ/Ｌｏ＝１の場合、迷光（６次不要回折光）の画質の劣化への寄与はないが、Ｌｍ/Ｌｏ＜０．８以下の場合は画質への劣化が顕著となる。
例えばＬｍ/Ｌｏ＝０．７３の場合で迷光の走査速度が一定であるならば、迷光が非走査面上に及ぼすエネルギー密度は像高によらず略一定で、画質の劣化が無いＬｍ/Ｌｏ＝１の場合にくらべ、Ｌｏ/Ｌｍ＝１/０．７３＝１．３７倍になる。よってスリット部材（制限手段）７のスリット開口部７ａを設けて迷光の一部を副走査方向に遮光し、エネルギー密度が０．７３倍（すなわちＬｍ/Ｌｏ倍）となるようにすれば、画質の劣化が無いＬｍ/Ｌｏ＝１と同じエネルギー密度と同等になる。このとき迷光の副走査方向の光束幅φｍのＬｍ/Ｌｏ倍以下にスリット開口７ａの幅を設定すればよい。
すなわち

$$S < \phi m \times Lm/Lo \quad \cdot\cdot\cdot \ (a)$$

ところが、実際のところ図１１に示すように迷光の走査速度は一定ではなく、軸上近傍で走査速度がほぼ一定あっても、軸外に移動するにつれ徐々に速度がさがる。この結果、軸上近傍に比べ像高Ｌｍ＝±８０ｍｍ近傍の方が迷光のエネルギー密度は大きくなる。迷光の走査域-８０～+８０ｍｍの範囲で平均したエネルギー密度は上記と同じくＬｏ/Ｌｍ＝１/０．７３＝１．３７倍であるが、Ｌｍ＝±８０ｍｍ近傍ではこれより更にエネルギー密度が高くなる。このため（ａ）式より多く迷光を遮光する必要がある。
本件構成では、主走査方向には遮光できないので副走査方向のスリット開口７ａを小さく設定する必要があり、

$$S < \phi m \times (Lm/Lo)^2 \cdot\cdot\cdot \ (b)$$

とした。
これの式を変形する事で
【数３】

$$\sqrt{(S/\phi m)} < Lm/Lo \cdot\cdot\cdot\cdot (3)$$

となる。
（４）拒絶理由通知の理由（１）に対する意見
（４－１）刊行物１、刊行物２の回折光学素子を用いた走査光学装置には、いずれも回折次数１を使用して、被走査面上を走査する走査光学装置の開示ある。また、回折光学素子からは、不要回折光も発生していると考えられるが、刊行物１、刊行物２の走査光学装置がＬｍ／Ｌｏ＜０．８を満たす系か否か不明である。
刊行物１、刊行物２には絞りの位置及び大きさが不足している為Ｌｍ、φｍの値が計算できない。
また、刊行物１、刊行物２には、請求項１の発明に係る制限手段に相当する部材の開示がない。従って、幅Ｓの値の開示もない。
以上のように刊行物１、２には請求項１の発明の構成（Ａ２），（Ａ３）が開示及び示唆されていない。
（４－２）刊行物３～７には、回折光学素子含む光学系において、不要回折光が迷光とな

ることの開示ある。しかしながら走査光学装置において、条件式（１）のＬｍ／Ｌｏ＜０．８を満たす走査光学装置や６次不要回折光の走査幅Ｌｍの値、制限手段の副走査方向の幅Ｓの値、６次不要回折光の副走査装置の大きさφｍの値の開示が全くない。

刊行物３～７には、請求項１の発明の構成（Ａ２），（Ａ３）が開示及び示唆されていない。

（４－３）刊行物８～１２には、請求項１の発明に係る制限手段に関係する遮蔽部材の開示ある。しかしながら、これを走査光学装置の回折光学素子から生ずる不要光の除去に適用する開示がない。

特に条件式（１）を満足する走査光学系に適用することや、６次不要回折光の走査幅Ｌｍの値、制限手段の副走査方向の幅Ｓの値、６次不要回折光の副走査装置の大きさφｍの値の開示が全くない。

刊行物８～１２には、請求項１の発明の構成（Ａ２），（Ａ３）が開示及び示唆されていない。

（４－４）以上のように刊行物１～１２には、いずれも条件式（１）を満足する走査光学装置において、結像手段に回折部（回折面）を用いて温度変化に伴う主走査方向の倍率変化及びピント変化を補正するときに、該回折面から生ずる反射６次回折光であって被走査面に結像し、有害光となる６次不要回折光を低減させるために、６次不要回折光の走査幅Ｌｍの値、制限手段の副走査方向の幅Ｓの値、６次不要回折光の副走査装置の大きさφｍの値を条件式（２）の如く設定することを開示及び示唆していない。

従って刊行物１～１２から、請求項１の発明の構成（Ａ２），（Ａ３）は当業者であっても導き得ない。

よって、請求項１の発明が刊行物１～１２より当業者であれば容易に発明することができ、特許法第２９条第２項の規定により特許を受けることができないとは思えない。

（４－５）本出願の請求項１以外の発明は、請求項１の構成を含んでいる。従って請求項１以外の発明は、（４－１）～（４－４）の項で述べた理由と同様の理由により、特許を受けることができないとは思われない。

（5）拒絶理由通知の理由（2）に対する意見

（５－１）理由、イ、ニ、ホに対する意見

同日付の手続補正書により、請求項１の発明を補正（旧請求項７、９、１０の構成を付加する補正）することによって、請求項１の発明の構成が明確になり、かつ当業者が実施できる程度になったので理由イ、ニ、ホは解消したと思料している。

（５－２）理由ハに対する意見

旧請求項３を削除した。

これによって理由ハは解消したと思料する。

（５－３）理由ロ、ヘに対する意見

『不要回折光の迷光の走査幅Ｌｍ』および『該制限手段の置かれた場所における前記不要回折光の副走査方向の大きさφｍ』がどのように導出されるかを以下に示す。

より具体性を持たせるために数値実施形態として示す。

本出願に添付した図１に示される結像手段６を構成するトーリックレンズ６１と回折光学素子６２との形状は各々、

（A）トーリックレンズ．．主走査断面内が１０次までの関数で表せる非球面形状、トーリックレンズの光軸との交点を原点とし、光軸方向をｘ軸、主走査断面内において光軸と直交する軸をｙ軸、副走査断面内において光軸と直交する軸をｚ軸としたとき、主走査方向と対応する母線方向が、

【数４】

$$x=\frac{Y^2/R}{1+(1-(1+K)(Y/R)^2)^{1/2}}+B_4Y^4+B_6Y^6+B_8Y^8+B_{10}Y^{10}$$

（但し、R は曲率半径、K、B_4、B_6、B_8、B_{10}は非球面係数）

副走査方向（光軸を含み主走査方向に対して直交する方向）と対応する子線方向が、
【数５】

$$S = \frac{Z^2/r'}{1+(1-(Z/r')^2)^{1/2}}$$

ここで $r' = r_0(1+D_2Y^2+D_4Y^4+D_6Y^6+D_8Y^8+D_{10}Y^{10})$
（但し、ｒ0は光軸上の子線曲率半径、D2 、D4 、D6 、D8 、D10は非球面係数）
（Ｂ）回折光学素子．．主走査断面内が１０次まで、副走査方向が主走査方向の位置により異なる２次の位相関数で表わされる回折面、
$\phi = m\lambda = b2\ Y2 + b4\ Y4 + b6\ Y6 + b8\ Y8 + b10\ Y10$
$+ (d0 + d1\ Y + d2\ Y2 + d3\ Y3 + d4\ Y4)\ Z2$
（但し、ϕは位相関数、ｍは回折次数、λは使用波長で780nm、Ｙはレンズ光軸からの高さ、ｂ２，ｂ４，ｂ６，ｄ０，ｄ１，ｄ２，ｄ３，ｄ４は位相係数、本件の通常走査光ではｍ＝＋１次回折光を使用、また6次の反射回折光ではｍ＝+6の反射光束としてあつかう）なる式で表わされる。
表－１に説明のために、結像手段６の数値例（設計値）を示す。
表－１においてトーリックレンズ６１の入射面を第１面、出射面を第２面、回折光学素子６２の入射面６3を第３面、出射面６4を第４面とする。第０面はポリゴンミラー５の偏向点とする。
【表１】

表１

面番号	面間隔	屈折率	
0	28.5	1.000	反射面
1	8.0	1.524	透過面
2	57.5	1.000	透過面
3	4.0	1.524	透過面
4	125.0	1.000	透過面

主走査形状

	R	K	B4	B6	B8	B10
1面	-6.222E+01	-2.511E+00	3.374E-06	1.680E-10	0.000E+00	0.000E+00
2面	-3.772E+01	-8.873E-01	2.165E-06	1.719E-09	0.000E+00	0.000E+00
3面	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
4面	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

副走査形状

	R	D2	D4	D6	D8	D10
1面	1.179E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2面	1.376E+01	-1.307E-04	8.246E-08	0.000E+00	0.000E+00	0.000E+00
3面	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4面	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

回折格子　次数m=+1

	b2	b4	b6	b8	b10
4面	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-21
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E+00	2.123E-13

本件においてF･θレンズとしてのF＝184.10　mm/rad である。よってLo/2=±110を走査する走査画角θｍａｘ＝±34.2°である。

また光源１からポリゴン５までの光路に設けられた入射光学系の配置は、

【表２】

	面	R(母線)	r(子線)	d	N
光源	-6	∞	∞	29.60	1
コリメータレンズ	-5	178.472	178.472	2.00	1.762
	-4	-26.645	-26.645	3.00	1
絞り	-3	∞	∞	6.52	
シリンダ	-2	∞	41.29	3.00	1.511
	-1	∞	∞	75.98	

であり、開口絞りは楕円形で紙面に平行な方向（主走査方向）の径が4.9、紙面と垂直な方向（副走査方向）の径が3.72である。

この数値実施形態（表１）における光線トレースは、市販されている光学光線トレースソフト（例えば、OPTICAL RESEARCH ASSOCIATES社の CODEⅤなど）や自社開発の光学トレースソフトで行なうことができる。本件の図１0に示される光線12は自社開発ソフトにより光線トレースしたものを図示化したものである。

これに対し、回折光学素子６２の出射面６4（第４面）で発生する6次の反射回折光が、回折光学素子６２の入射面6３（第3面）で表面反射し、再度回折光学素子６２の出射面６4（第４面）で1次の透過回折光として被走査面９に向かう不要回折光の迷光のトレース方法は以下のように光学は位置情報を設定して行う。すなわち第4面での6次の反射光に対する面情報を第４’ 面、第3面での表面反射光に対する面情報を第3’ 面という2面を追加することでトレースさせる。具体的には表２のようになる。

【表３】

表２

面番号	面間隔	屈折率	
0	28.5	1.000	反射面
1	8.0	1.524	透過面
2	57.5	1.000	透過面
3	4.0	1.524	透過面
4'	-4.0	-1.524	反射面
3'	4.0	1.524	反射面
4	125.0	1.000	透過面

	R	K	B4	B6	B8	B10
1	-6.222E+01	-2.511E+00	3.374E-06	1.680E-10	0.000E+00	0.000E+00
2	-3.772E+01	-8.873E-01	2.165E-06	1.719E-09	0.000E+00	0.000E+00
3	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
4'	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3'	-4.060E+02	2.820E+01	5.962E-07	-8.980E-11	8.342E-15	0.000E+00
4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

1	1.179E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
2	1.376E+01	-1.307E-04	8.246E-08	0.000E+00	0.000E+00	0.000E+00
3	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4'	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
3'	6.000E+01	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00
4	∞	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

回折格子　次数m=+6

面	b2	b4	b6	b8	b10
4'	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-21
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E+00	2.123E-13

回折格子　次数m=+1

面	b2	b4	b6	b8	b10
4	-1.696E-04	-1.141E-08	-3.000E-12	2.000E-16	-7.000E-21
	d0	d1	d2	d3	d4
	-4.909E-03	2.843E-07	5.377E-07	0.000E+00	2.123E-13

この数値実施形態（表2）における光線トレースも同様に、光学トレースソフトで行なうことができる。本件の図１（主走査断面図）に示される迷光13は自社開発ソフトにより光線トレースしたものを図示化したものである。

図１の『不要回折光の迷光の走査幅』の範囲Lmは、Lo/2=±110を走査する走査画角θmax=±34.2の範囲に対して、迷光１３が走査する範囲である。つまり表２の数値実施形態に対し走査画角θmax=±34.2°の範囲の走査画角θに対して光学トレースソフトでトレース

し、被走査面上のどのポイントに到達するかをトレースしたこと事により算出することができる。走査その範囲は明細書［００４７］および図１１に示すようにおおよそ±80（Lm=160）である。

図１１には主走査方向の主光線および２つのマージナル光線が、被走査面上のどのポイントに達するか示している。２つのマージナル光線を決めているのは上記開口絞り３（主走査方向の4.9の幅）である。

一方『該制限手段の置かれた場所における前記不要回折光の副走査方向の大きさ』も同様な手法で算出することができる。具体的には、表２では回折光学素子６２の出射面６４（第４面）から被走査面までの距離を１２５としてトレースした。制限手段７は本文［００３９］などに示されるように、回折面64と被走査面９の間に設けられる。よって回折面64と制限手段７の距離Xは125以下である。制限手段７上での迷光の振る舞いをトレースするためには、表２の数値実施例に対し、面4の面間隔125をXに変更して光学トレースソフトを使用してトレースする事で算出することができる。本件の図2（副走査断面図）に示される迷光13は自社開発ソフトにより光線トレースしたものを図示化したものである。図２に示される迷光１３は副走査方向のマージナル光線であり、２つのマージナル光線を決めているのは上記開口絞り３（副走査方向の3.72の幅）である。

以上の説明によって、『不要回折光の迷光の走査幅Ｌｍ』および『該制限手段の置かれた場所における前記不要回折光の副走査方向の大きさφｍ』がどのように導出されたか明確になったと思料している。

尚、以上の技術的内容は、本出願の明細書から、当業者であれば容易に理解できると考えている。

これによって理由ロ、ハは解消したと思料している。

（５－４）以上の説明により拒絶理由の理由（２）は解消したと思料する。

（６）以上の如くなので、本出願に対する前記拒絶理由の理由（１）、（２）は存在しないと思料する。よって再度ご審査の上、本出願に対して速やかに特許査定をすべき旨の決定をお願いする次第である。